AN OBJECTIVE MEASURE OF ATTRIBUTIVE CLEARNESS[1]

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Many efforts have been made and many methods have been used to discover a reliable measure of attention: a problem which Külpe long ago characterised as "one of the most important . . . . that await solution. . . . ."[2] Its attractiveness lies in the fact that it is of as great significance for practical and applied purposes as it is for theoretical and systematic psychology.

Since Geissler has reviewed the work done up to 1909,[3] we may dispense with an historical introduction, and give merely a summary of his conclusions. He found that the methods employed fall into six classes. "The first five may be classed together as methods of expression, analogous to the physiological methods employed in the investigation of the affective processes. According to these five methods the degrees of attention may express themselves in changes of (1) peripheral vision; (2) muscular strength; (3) liminal and differential sensitivity; (4) reaction-time; (5) accuracy of work. The sixth method may be likened to the method of impression. By a series of graded distractors, different degrees of attention are to be induced in the observer, and he is afterwards to report which degree he experienced."[4] From an examination of the published studies, Geissler concluded that the results are equivocal, and that for one reason or another the methods themselves are inadequate to the problem. "Although much effort has been spent upon it [the problem of measuring attention], we are still far from a satisfactory solution."[5]

Geissler, at Titchener's suggestion, adopted a new method. He proposed to measure attention in terms of attributive clearness, the single characteristic of attention upon which all writers, theoretical as well as experimental, seemed to be agreed. The attempt thus made yielded positive results, and the method itself seemed so promising that it was extended by Dallenbach to the fields of auditory and cutaneous sensation.[6] Confirmatory results were obtained in both sense departments. *Attention can be measured in terms of attributive clearness.*

Dallenbach found further, in both of his studies, that under the conditions of his experiments the reaction-time and the mean variation of this time offered reliable means for the measurement of attention. There was a positive correlation between attention introspectively estimated in terms of attributive clearness and the rate of reaction,[7] and also between attention thus estimated and the mean variation of

[1] From the Psychological Laboratory of Cornell University.

[2] Külpe, O., *Outlines of Psychology*, (1892) 1895, 429.

[3] Geissler, L. R., *Am. J. of Psy.*, XX, 1909, 473-529.

[4] *Op. cit.*, 492.

[5] *Op. cit.*, 502.

[6] Dallenbach, K. M., *Am. J. of Psy.*, XXIV, 465-507; XXVII, 1916, 443-460.

[7] *Op. cit.*, XXIV, 483-485; 501-502; XXVII, 453-455.

the reaction-time.[8] His observers, however, were not under the *Aufgabe* of reaction; they did not even know that their reactions were being timed; and he was therefore cautious in drawing his conclusions. "It is possible that a 'reaction' of this sort indexes attention, whereas a formal and set reaction, so understood by the reactor, is too complex a matter to serve as an index."[9]

In our recent work upon "The Effect of Auditory Distraction on the Sensory Reaction"[10] we took advantage of the opportunity offered to test the relation of clearness to the length of the sensory reaction. One of the observers, D, who was trained in the introspection of clearness, gave, after every series of 10 reactions, an estimation of the clearness-values of the processes involved during that period.

Three kinds of distractors were used: a metronome, beating during a series of 10 reactions; a bell, ringing just before and during the separate reactions; and a tuning-fork, sounding continuously throughout the entire period of distraction experiments. During the employment of every distraction, 100 distraction-series, and 33, 20, and 40 control series respectively, were obtained. A series consisted of 10 reactions.

The averages of the averages of the series, and the averages of the mean variations of the series, have been tabulated for every method of distraction according to the clearness of the processes involved. These data appear in Table I.

TABLE I

Average Series Reaction, Average Series Mean Variation, and Number of Series for every Degree of Clearness, under every Mode of Distraction

Distractor		Clearness					
		100–90	90–80	80–70	70–60	60–50	50–40
Metronone	Average	198.6	205.6	208.2	199.4	171.9	219.0
	Mean var.	14.8	17.9	21.0	23.0	24.0	27.2
	No. Series	41	37	7	4	1	2
Bell	Average	201.3	216.9	221.2	226.5	233.4	
	Mean var.	19.3	21.5	22.0	25.8	35.1	
	No. Series	18	37	50	14	1	
Tuning-fork	Average	218.9	220.2	231.3			
	Mean var.	17.9	19.0	21.9			
	No. Series	72	65	3			

Opposite the word "Average" appears, for every level of clearness, the general average of the averages for the separate series; opposite "Mean var." appears the general average of the mean variations for every series; and opposite "No. Series" appears the number of series used for computation.

The number of series under the distraction of the metronome totals only 90, whereas, as we have shown above, 133 series were actually taken. The discrepancy is due to the fact that clearness-estimations were not given until the observer had become accustomed to method and report of the main experiment. It was not until 40 series had

[8] *Op. cit.*, XXIV, 485; 501; XXVII, 455-456.

[9] *Op. cit.*, XXIV, 485.

[10] Cassel, E. E., and Dallenbach, K. M., *Am. J. of Psy.*, XXIX, 1918.

been taken that D included introspective evaluations of clearness in his reports.

Table I shows that the higher levels of clearness have the shortest reaction-time. There are but two cases in which a lower level gives a shorter average reaction than the next higher; and both of these should be (and were) excluded from the computation of the correlation, since they were the averages of too few series (4 and 1 respectively). In fact, all averages obtained from less than 7 series were excluded from the computation, though this procedure tended to lower the coefficients of correlation. Calculated by Pearson's familiar "product moments" method, the results are:

Distractor	*Correlation*	*P. E.*
Metronome	0.987	0.009
Bell	0.967	0.016
Tuning-fork	0.999	0.0006

The higher levels of clearness have also the smallest mean variation. In not a single instance is the average variation of the reactions of a higher level as large as that of a lower. The coefficients and probable errors of the correlations between degrees of clearness and degrees of precision (calculated as above) are:

Distractor	*Correlation*	*P. E.*
Metronome	0.961	0.005
Bell	0.913	0.012
Tuning-fork	0.984	0.002

These data show that the rate of a simple sensory reaction, and its degree of precision as expressed by the m. v., are both (under our conditions) reliable means of determining the degree of clearness. It therefore follows, since attention itself is measurable in terms of clearness, that these objective measurements also give us a reliable index of attention.

It may be urged, in objection, (1) that the observer's reports, inasmuch as they were delayed until after the completion of 10 reactions, partake more of the nature of vague impressions, of guesses, than of true introspective descriptions; and (2) that the figures, inasmuch as they are averages of averages, are artificial and not representative. To meet these objections, and further to check the method and results, the observer, during the last 5 days of the experiment,

TABLE II

Average Reaction-Time, Mean Variation, and Number of Cases for Different Levels of Clearness

Distractor		Clearness				
		95	90	85	80	75
Metronome	Average	214.08	219.87	231.45	241.37	246.00
	m.v.	16.1	18.4	20.0	24.7	.....
	No. cases	68	431	173	27	1

reported upon the clearness of his mental processes immediately after every reaction. 100 distraction-reactions and 40 control reactions were

made every day: 700 cases in all.[11] These were distributed according to the clearness of the auditory sensations from the sound-hammer. The averages, the mean variations, and the number of cases for the different levels of clearness are brought together in Table II.

The relation between level of clearness, rate of reaction, and mean variation is remarkably constant. The coefficients of correlation (as figured by Pearson's method) are:

Correlation of Clearness with		*P. E.*
Average Reaction	0.992	0.003
Mean Variation	0.972	0.013

These results corroborate those of the rougher determinations. Since they were obtained from a single observer, who was highly practised both in reaction and in introspection of clearness, we have no right to generalise them. The correlation is, however, so high and so constant, and persists through such marked shifts of attitude,[12] that we may conclude at any rate that, under these conditions of training, attributive clearness may be measured by the average duration and mean variation of the simple sensory reaction.

[11] D gave in all 1050 introspective reports of clearness. It is certain that he belongs to the dual level type; all of his reports without exception showed a clear focus and a vague background which varied reciprocally.

[12] In the study of which this is a corollary we found that D's attitude changed frequently during the course of the experiment, and also that the reaction-time varied with attitude. The present experiment shows that reaction-time is closely correlated with clearness. It would therefore appear that clearness and attitude are interrelated: as, indeed, is definitely indicated by the results of earlier experiments. We hope to return later to this general subject.